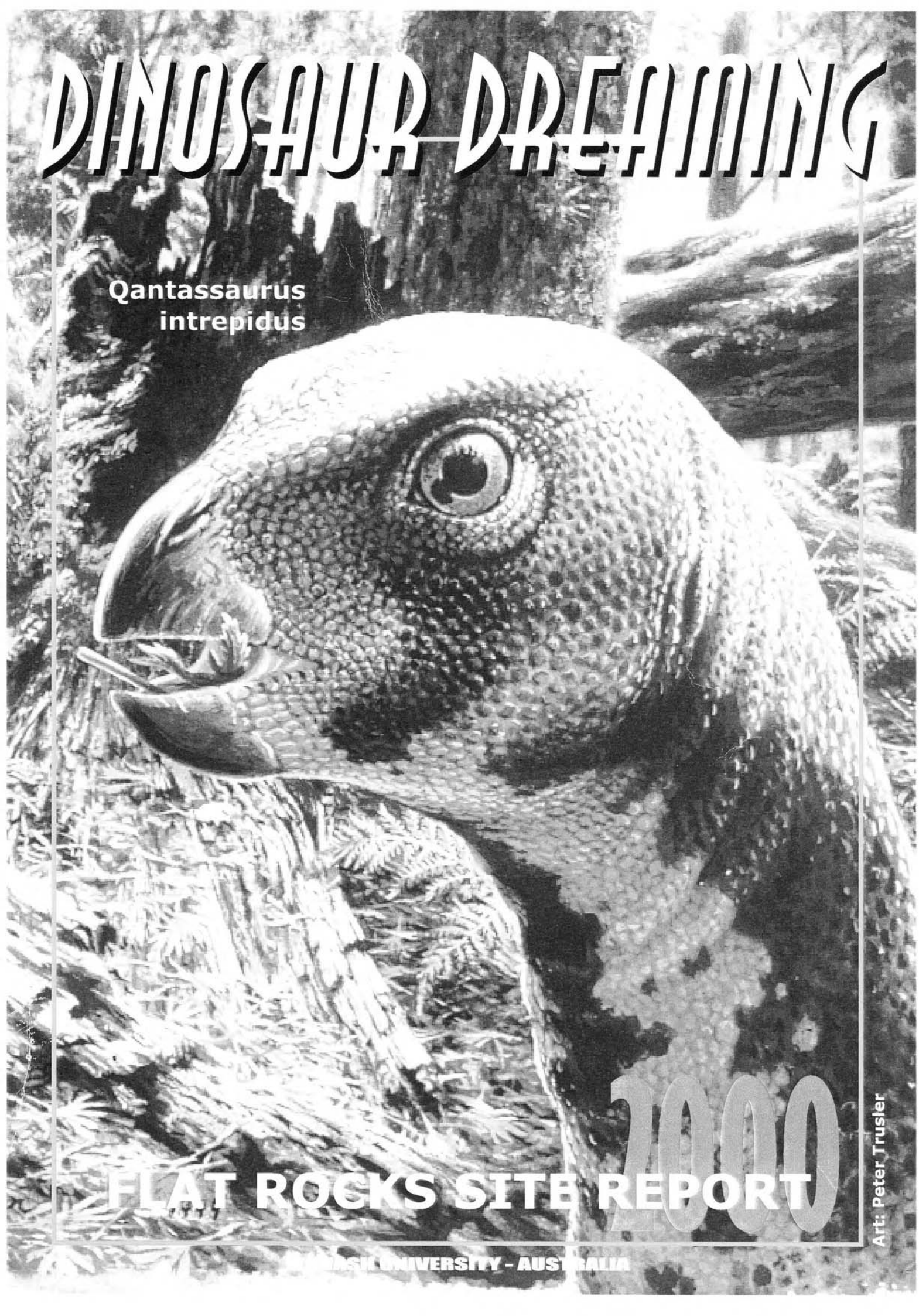
DINOSAUR DREAMING



FLAT ROCKS SITE REPORT 1999

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Tom Rich - research report

Doris Seegets-Villiers - taphonomic report

Katch Bacheller - field report

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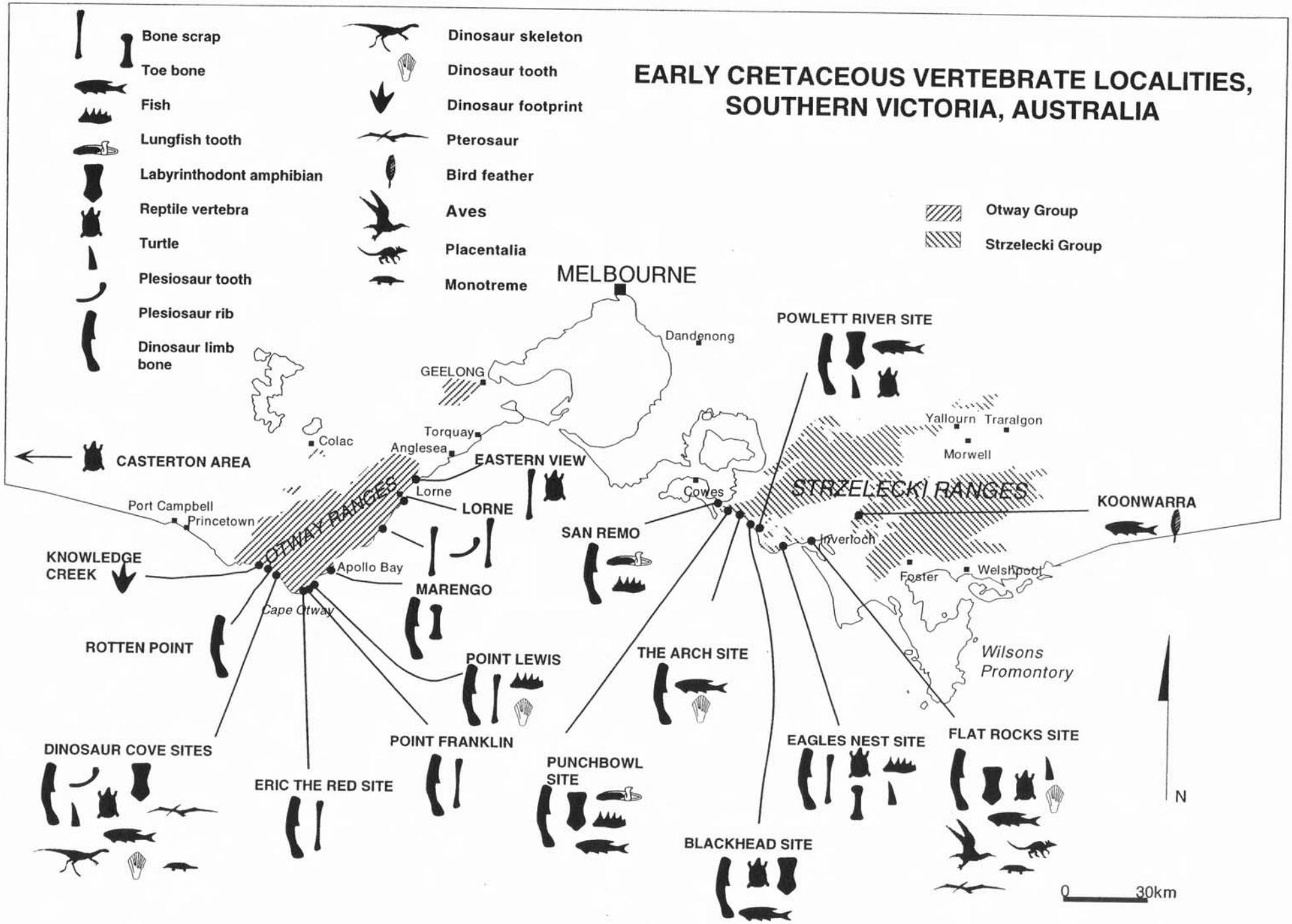
DINOSAUR DREAMING 2000
ANNUAL REPORT

Field Report by Lesley Kool:

The crew members of the Dinosaur Dreaming 2000 field season knew that it was going to be difficult to improve on the previous year's results. But much to our delight that is exactly what we did and produced the best field season to date. Not only did we catalogue nearly 1000 bones and teeth, but we also found four more tiny mammal jaws. Two jaws were identified during the dig; the other two did not come to light until after the dig when the laborious task of checking all the collected specimens began. It was only after closer scrutiny that the third and fourth jaws were identified and prepared, resulting in the most jaws found in one season.

The Flat Rocks site, which is the principal site of the Dinosaur Dreaming project, was discovered in 1991 as part of a prospecting program conducted jointly by Monash University and the Museum Victoria. It is situated on the southern coast of Victoria approximately 150 kms south-east of Melbourne (see location map). The main part of the fossil layer lies within the intertidal zone and is only accessible for 3-4 hours either side of low tide at this site. The site's position has resulted in a number of logistical problems, including the daily inundation of the excavation by the incoming tide and the sand that accompanies it. We are fortunate to have the ingenuity of Nick van Klaveren, the site excavation manager, who learned all about rock removal from difficult localities at Dinosaur Cove in the late 80's and early 90's. At the end of the 1997 field season it was taking in excess of two hours to remove the sand from the excavation, leaving very little time to remove the fossil layer before the tide started coming in again. It was very obvious that some system was needed to prevent the bulk of the sand from filling the excavation with the incoming tide. Nick spent a great deal of time speaking to engineers and eventually came up with a system of tarpaulins, plastic bottles, steel mesh and girders, which we implemented during the 1998 field season. The system took time to refine and modify, and each successive field season has seen some improvement. This field season saw the addition of a much stronger tarpaulin, kindly made and donated by Evan Evans Flags, which protected the underlying layers far better than in previous years.

Doris Seegets-Villiers continued her data collecting with the able assistance of Mary Walters. Doris used a system of arrows and marks on the fossil layer to allow her to determine the palaeo-direction of the limb bones in relation to the palaeocurrent of the original river. Once again Nick van Klaveren came up with an ingenious method of quickly calculating the compass direction, thereby speeding up the data collection.


EARLY CRETACEOUS VERTEBRATE LOCALITIES, SOUTHERN VICTORIA, AUSTRALIA
Bone scrap
Toe bone
Fish
Lungfish tooth
Labyrinthodont amphibian
Reptile vertebra
Turtle
Plesiosaur tooth
Plesiosaur rib
Dinosaur limb bone
Dinosaur skeleton
Dinosaur tooth
Dinosaur footprint
Pterosaur
Bird feather
Aves
Placentalia
Monotreme
Otway Group
Strzelecki Group
MELBOURNE
Dandenong
GEELONG
Torquay
Anglesea
Colac
CASTERTON AREA
EASTERN VIEW
Lorne
LORNE
Port Campbell
Princetown
OTWAY RANGES
KNOWLEDGE CREEK
Apollo Bay
MARENGO
Cape Otway
ROTTEN POINT
POINT LEWIS
POINT FRANKLIN
DINOSAUR COVE SITES
ERIC THE RED SITE
PUNCHBOWL SITE
SAN REMO
Cowes
THE ARCH SITE
BLACKHEAD SITE
POWLETT RIVER SITE
Yallourn
Traralgon
Morwell
STRZELECKI RANGES
KOONWARRA
Inverloch
Foster
Welshpool
Wilsons Promontory
EAGLES NEST SITE
FLAT ROCKS SITE
N
0
30km

Towards the end of the six-week field season a number of cores were drilled in the floor of the excavation and to the north of the working face (see Nick's report). The information gained from these cores will assist Doris in her study of the stratigraphy i.e. position of the fossil layer, as well as confirming or denying that there are no more fossiliferous layers below the known layers.

The sedimentary rocks that make up the Strzelecki Group, which outcrops along the Victorian south coast between San Remo and Inverloch, have been palynologically dated at approximately 115 million years old. At this time in history Australia was still attached to Antarctica forming the last remnant of the once Great Southern Land of Gondwana. The animals that lived and died in these high latitudes would have experienced at least three months of darkness each polar winter and yet the evidence being uncovered by the Dinosaur Dreaming team suggests that there was a high diversity, not found at other polar sites.

Of the nearly 1000 fossil bones and teeth collected during the six-week dig, less than 10% have since been prepared. The preparation of these often small, fragile bones is very time consuming and it will probably be years before most of the fossils collected over the last seven field seasons have been prepared. However, from the small percentage that has already been prepared, we have some insight into the different animals that lived in this unique environment.

Three of the mammal jaws recovered this field season belong in the family Ausktribosphenidae, but at least one of them is a new genus and species, which Tom Rich elaborates on in his report. The fourth mammal jaw is possibly the second specimen of *Teinolophus trusleri* collected from this site. Unfortunately, this second specimen is lacking teeth, but possesses other features, which enable Tom to place it within this group of enigmatic mammals.

The preparation of the tiny mammal jaws was greatly enhanced by the expertise of Charles (Chuck) Schaff. Chuck was invited by Tom and Pat Rich to advise and assist in the preparation of a particularly difficult specimen that was discovered during the Dinosaur Dreaming 1999 field season. Chuck is currently head preparator at Harvard University in Boston, U.S.A., and has worked on fossil mammals for the last 30 years. When I displayed some apprehension in the preparation of the mammal jaw last year, Chuck was asked for his assistance.

Chuck arrived in Australia just after last year's "Friends of Dinosaur Dreaming" evening. We only had a week to prepare the specimen, which was not long enough, so Chuck decided to take it back to the U.S. with him. Not only did Chuck bring his own tools with him, but he introduced me to new preparation techniques that I was unaware of, which have been of great assistance in the preparation of subsequent jaws. He also very kindly left many of his tools for me to use, as some of them are unavailable in Australia.

The mammal jaws were not the only success of the season. It appears that at least two possible bird bones were also collected, which Professor Pat Vickers-Rich will be studying in the near future along with at least 3 other specimens collected in previous years. Fossil bird bones are very rare in the fossil record. Bird bones are thin-walled and hollow, which means they are often destroyed before they can be

preserved. Fossil bird feathers have been known from another Early Cretaceous site near Koonwarra in South Gippsland. These feathers were discovered in the 1960's when the South Gippsland Highway was developed through the Strzelecki Ranges. Six small down feathers were the only evidence of birds in the Early Cretaceous until a small furcula was recovered less than a week before the first mammal jaw turned up during the 1997 field season. This small bone gave us the first skeletal evidence of birds and since then a number of other small gracile hollow bones have been recovered.

Apart from the tiny mammals and the birds we have evidence of at least five types of dinosaurs. The most common dinosaur that appears to have thrived in these polar conditions belongs to a family of small bipedal, plant-eating dinosaurs called Hypsilophodontidae. Their fossilized bones and teeth have been found on every continent. There were at least two different genera of hypsilophodontids living in the area now known as Inverloch. One of these was officially named *Qantassaurus intrepidus* last year. The second group of hypsilophodontids from the Flat Rocks site was far more gracile than *Qantassaurus* and has yet to be identified. This field season saw the recovery of an upper and lower jaw belonging to the latter group of hypsilophodontids, as well as nearly 30 isolated teeth of these very successful little dinosaurs.

The Dinosaur Dreaming 2000 field season also produced more theropod dinosaur teeth than in the previous three field seasons. Ten theropod teeth have been prepared since the end of this year's dig, all are "shed" teeth, having fallen from the mouths of the small meat-eating dinosaurs while they were still alive. All have serrations on the front edge of the tooth, but not along the back edge. This is unusual, as most theropod dinosaur teeth from elsewhere in the world have serrations on both the front and back of the tooth. Since collecting at the Flat Rocks site began in 1992, nearly 50 theropod dinosaur teeth have been recovered. Hopes were high this year to find a theropod dinosaur jaw or skull fragment with teeth in it, so a more accurate identification of this group of dinosaurs could be made. But, to no avail. Maybe next year.

The theropod teeth are not the only evidence of these small meat-eating dinosaurs. A number of hollow, thin-walled phalanges or toe bones have also been found, which could very well belong to this group.

Another dinosaur group initially identified by their teeth are the ankylosaurs. Two isolated ankylosaur teeth were recovered from this year's field season after three years absence. Their presence at this site is usually evident by the large number of dermal ossicles or skin armour that are found almost on a daily basis. These small button-like bones formed the "chain-mail" in the skin of these armoured dinosaurs. They surrounded the larger dermal scutes, which were the main form of protection for these plant-eating dinosaurs. One animal would have possessed thousands of the tiny dermal ossicles, so it is not surprising that so many are found at the site.

Three small teeth unlike any of the other dinosaur teeth were also found during this year's field season. They are bilaterally flattened like the theropod teeth, but are straight with unserrated keels. They show evidence of having possessed a root, which means they are not fish teeth. With the discovery of four fused cervical

vertebra from a small pterosaur in 1996, it is thought that these teeth possibly belong to this group. Again, more research is necessary to compare them with the teeth of pterosaurs overseas, as no other Australian pterosaur teeth are available for comparison.

An interesting aspect of this year's field season was the recovery of a large number of skull elements that were recovered. Dinosaur skulls are made up of loosely sutured skull elements, and if the dead dinosaur is not buried very soon after death, the skull tends to fall apart into these individual elements. A large number of beautifully preserved skull elements were collected, and some have been prepared. It is hoped that comparison with the skulls of dinosaurs from Australia and overseas will help us to identify these fossils.

Nearly one hundred years ago a geologist named William Ferguson found the first dinosaur bone from this continent. The site of this exciting discovery is situated only one kilometre from the main excavations at Flat Rocks at a popular tourist area called Eagles Nest. Ferguson's map did not give exact details of the location of this important fossil. However, a few year's ago, Mike Cleeland, a local geologist and one of the members of the prospecting group that originally discovered the Flat Rocks site, thought he may have rediscovered the Ferguson site. On a day in 1995 when the sand was particularly low at Eagles Nest, Mike came across a fossil layer usually covered in sand where he found half a dozen small bones exposed on the surface. Since that day we have revisited the site a few times and surface collected a few more bones, including a large hypsilophodontid femur. This field season it was decided to send a small crew to the site, and excavate some of the fossil layer. Two one-day field trips were assigned to the site and a total of 24 bones were collected, including the upper half of an unusual humerus (upper arm bone), which could be from a bird.

The Ferguson site, as it is now called, is not an easy site to excavate. There is even less access to the fossil layer between high tides than at the Flat Rocks site and the rock is much harder. But the number of bones collected in the two one-day digs was promising and the quality of the fossil preservation is very good. The presence of fossil birds is encouraging, and Tom Rich is hoping that the site may produce some mammal material. So, it has been decided that more one-day digs at the Ferguson site will take place during Dinosaur Dreaming 2001.

There were a couple of frustrating episodes during the dig when first the rocksaw and then the generator expired. Thanks go to the *Friends of Dinosaur Dreaming* whose subscriptions helped us replace both pieces of equipment. We were able to show off the new equipment at the annual 'Friends' day. After extreme ranges of weather during the earlier part of the season, Friends Day dawned bright and sunny and more than 100 'Friends' took advantage of the day to see us at work.

Excavation Report by Nicholas van Klaveren

The Flat Rocks fossil locality was excavated for a period of six weeks, from mid-January to the end of February 2000. This was two weeks earlier than usual, so that the excavation period coincided with the university holidays. All material was collected under permit number 1000700 of the Department of Natural Resources and Environment, Victoria.

For a third year a temporary construction of tubular steel beams, rock anchors, steel mesh, tarpaulins and numerous twenty litre plastic drums was built to help exclude sand and water from the working area.

Excavation Methods

The excavation method this year continued with the use of large iron wedges and sledge hammers to remove the bulk of the fossil layer from the targeted area. Exposed specimens were removed with a diamond saw blade equipped Stihl TS460 Cutquik. The technique of removal used last year was continued with wedges driven into the semi-continuous coal layer at the base of Middle Sandstone Unit, then a second level was extracted with the wedges driven into the Lower Sandstone Unit.

The unfossiliferous sandstone overburden laying on top of the fossil layer was removed chiefly with the two Cobra petrol driven jackhammers with the assistance at the start of the dig by the compressed air-driven Tex 22, which proved to be considerably more powerful than the former. Once the majority of the overburden was removed, the method was then switched to sledge hammers and wedges so as to provide greater control to protect the underlying fossil layer from damage.

Equipment:

The Flat Rocks fossil locality, due to its location at the bottom of a cliff in the intertidal zone facing Bass Strait, presents a number of difficulties with regard to the difference in elevation and large waves at high tide.

For the past two years, a construction consisting of packing material, plastic tarpaulins, steel mesh and iron beams bolted to the rock was built to help exclude sand and thereby increase access time to the fossiliferous units.

A number of innovations were tried this year to improve the system introduced two years ago:

Rocksaw:

This season saw the demise of the Stihl TS 460 Cutquik. It was found that salt water had caused corrosion throughout the machine with terminal failure of the gearbox and clutch. A replacement TS 460 was procured and a change to dry cutting was made to minimize the exposure to water. Examination of the diamond blade at the end of this season showed only minute wear due to the relative softness of the rock.

Generator:

This year also saw the demise of our large 5 KVA generator (of Dinosaur Cove vintage) which suffered a burn out in the electric generator. The engine still remains functional so it is possible a repair may be made at a future date. A new and much lighter 2.5 KVA generator was procured and had adequate power to run both the electric pumps (at a noticeably increased rate compared to the old generator, probably due to wear in the brushes).

Dewatering:

The two electric pumps were used almost exclusively throughout this year's field season. The petrol pumps, which were difficult to prime and noisy, also produced noxious fumes (two stroke) so were infrequently used. The electric generator (easily started) can be kept at a distance with a long extension cord, where noise and fumes are minimized.

After the dig this year, the two electric pumps were overhauled with new cords and converted to manual operation with the removal of the automatic float switches.

A plastic pipe this year was installed between the deepest eastern part of the main excavation and sump 1. It filled with sand however and was no better at carrying water to the sump than the surrounding sand.

Survey Equipment:

A device consisting of a large perspex disk with 360 degree graduations around the edge (a planar alidade) was introduced into the survey procedure. The alidade can be read to an accuracy of around half a degree and was affixed to one of the short pins on the northern end of the excavation.

A permanent north point was carefully marked on a nearby rock allowing the alidade to be set up the same way each day. This eliminates the small errors using a hand held compass, which is difficult to hold steady in bad weather.

The survey staff and line level continued as the method of choice for the other half of the surveying tools.

The Construction:

This year the construction was installed in record time in under three days. Problems were encountered with the reuse of the previous year's rock anchors as the nuts were rusted on tight. Most of the nuts were persuaded to move again, but two had to be cut off with a steel cutting blade on the cutquik rocksaw.

Another problem encountered with one of the rock anchors was that it was pulled up by the force of the tide, releasing a few drums. A number of factors probably caused this failure:

- Failure to completely ream the build up of clay on the hole walls after drilling, leading to difficulty in correct placement of the expander down the hole.

- Overzealous hammering of the anchor down the hole leading to damage of the thin metal bracket holding the expanders, this gives rise to a situation where the two expanders are at different heights in the hole.

- Wear of the sides of the drill bit, producing a hole of narrower width (unlikely as the problem hole was the second of fourteen drilled, but may contribute to the first reason above).

All these factors probably contributed to the failure and will be remedied next year by increased reaming with running water and more care during emplacement and a return to cement grouting to add extra strength.

Mesh:

The mesh this year was reused from the previous year and only lasted till the end this season. Most damage to the mesh appears to occur when the overlying beams are tightened up causing the welds to break between the beam and the nut below. To remedy this, a washer could be used to hold the mesh below the nut, but would also entail extra care to make sure the mesh was not caught between the beam and the nut.

A new method of note that was implemented this year was the placement of the mesh with the long wires downward. This limits the damage by the ends of the wires to the underlying tarpaulins, to the outer ends and one line across the middle instead of all over.

Tarpaulins:

The new heavy duty plastic truck tarpaulin, donated by Evan Evans Flags, was used for the first time this year. It worked well in protecting the other tarpaulins from damage from the mesh and wayward shovellers. This allowed less sand to penetrate as there were not the usual tears and holes in the top surface. At the beginning of the dig it was at first used by itself and considerable sand got under the edges, but with a return to the enveloping cheap blue tarpaulins beneath most of the sand was excluded.

It appears that the upward force of the drums sandwiches the many tarpaulins together against the mesh to form a seal against the sand.

Derrick:

The portable derrick constructed to raise the drums up the cliff at the end of the dig once again had problems. An improvised pulley wheel did not work well, with the rope jumping off the wheel when placed under load. The original system of eyelets was reinstated and the system worked well with the new hinge surviving the day.

Excavated Areas

Area 1

This was the main excavation area (see map 1) and concentrated on removing the fossil layer uncovered the previous year and an additional 1.8 x 2.0 metre area to the west (toward the cliff). The topmost fossil unit was found to lens out to the west, becoming homogeneous, unfossiliferous massive sandstone. The middle units were notably richer with a number of large limb bones recovered. The lower units around the sump 2 area (although thicker) were poorer in both quality of fossils and overall number.

These lower units were excavated from east to west, but excavation was discontinued at the edge of sump 2 due to the scarcity mentioned above.

Area 2

The small surface excavation at area 2 to the west of the main workings, was periodically worked on one day field trips during 1999 and on adverse tide days during the 2000 dig when tide times did not allow opening of the construction. Initially fossils produced from this area tended to be turtle and fish remains common to the lower units, but with the deepening excavation larger amounts of the middle unit were excavated.

The middle units, initially thought to be poorer due to the comparative lack of exposed surface bones proved to be much richer with cranial elements recovered.

This augurs well for the long-term future of the site with the down dip reserves of fossil matrix limited by increasing depth and lensing out to the east and northeast.

Diamond Drill Holes

Five vertical diamond core holes (see map 1) were drilled in the last week of the dig. Four of which were stratigraphic and structural holes (FRD 1 – 4). The fifth (FRD 5), an exploration hole, was drilled to investigate whether any additional fossiliferous lenses were underlying the thicker units at sump 2. No extra or anomalous units were encountered by FRD 5 and it was terminated 10 cm into the underlying mudstone. The first four holes all encountered the conglomerate units, which contain the fossils found in the main excavation area.

The first hole lacked the upper contact due to core loss because of core falling out of the core barrel during recovery. This necessitated the manufacture of a core catcher using plastic flanges made from PET bottles. This system, although fragile and needing frequent replacement, worked well for the remaining four holes.

Future Plans

Next year's excavation site will move to the east toward the sea and down dip to the north (see map 3). Expected problems are internal drainage pooling along the down dip face and entrapment of sand on top of the construction due to its inset position with rock faces on three sides. This area was selected because it is the down dip continuation of the richest zone of the upper two fossil units.

A new technique will be introduced next year and will consist of wooden beams holding down the tarpaulin edges using rock-sawn grooves between the short northern rock anchors. The previous way of holding down the rockward tarpaulin was by piling sandbags along the edges, most of which were removed by the force of the waves.

DINOSAUR DREAMING 2001

It is anticipated that the Dinosaur Dreaming 2001 field season will run for the usual 6 weeks duration, commencing in the last week of January 2001.

The training program conducted prior to the start of this year's field season proved itself once again with the recovery of nearly 100 fossil bones and teeth, including the 4 tiny mammal jaws. It is essential that new volunteers know exactly what to look for when they break open the fossiliferous rock. So many of the bones and teeth are very small and could easily be missed without proper training and the use of a hand lens.

It became apparent during the second half of the field season that there was a recognisable concentration of bones occurring on the boundary between the upper sandstone and the top fossiliferous layer. Dinosaur Dreaming 2001 will follow the downhill continuation of this boundary in the hope that this concentration of bones continues.

Research Report by Tom Rich:

Four specimens discovered during the 2000 dig at Inverloch bring the total of jaw fragments of mammals now known from there to an even dozen. That means that more than half the Mesozoic mammals now known from Australia came from that one site.

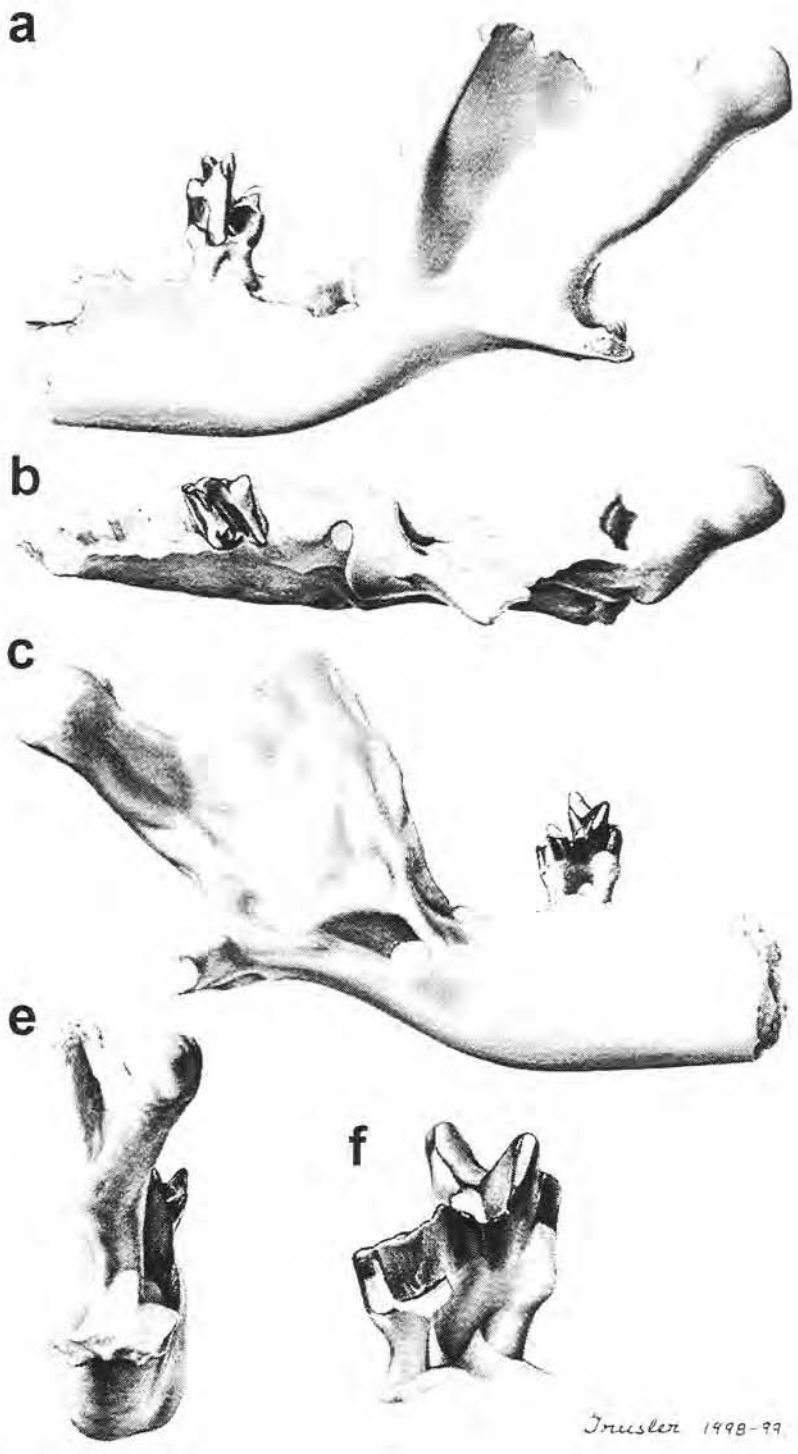
Amongst the four new specimens was one jaw with two heavily worn teeth, an individual that had obviously lived to a ripe old age for its species. Enough remained of it, however, to demonstrate that it was a new genus and species of ausktribosphenid; *i.e.* a close relative of the first mammal found at Flat Rocks in 1997, *Ausktribosphenos nyktos*. Comparison with the other mammalian specimens collected earlier from Flat Rocks revealed that a jaw fragment found in 1999 by Katch Bacheller with one beautifully preserved molar (from an individual, which unfortunately for it, but fortunately for us, died much younger) belonged to the same

previously unknown genus and species. While a new mammal is interesting, this new one is exceptionally so. This is because it is more advanced towards the condition typical of the majority of placental mammals than *A. nyktos* in a number of features of the jaw and molar. This bolsters the argument that the ausktribosphenids are somehow closely related to the placentals or are, in fact, placentals in the strict sense of the word, an hypothesis that is still widely doubted amongst vertebrate palaeontologists. Those of us involved directly in the study of the ausktribosphenids, too, remain sceptical of that hypothesis. But as the evidence for placental affinities for the family continues to increase, we find it more and more difficult to defend the alternative interpretations. The new genus and species will be described shortly and the manuscript first submitted to the scientific journal *Nature* for consideration for publication there.

Unfortunately, who found "grand dad", the first specimen of this new ausktribosphenid to be recognised as new, is unknown. Lesley Kool realised it was a jaw only when she had partially prepared it in March after the 2000 dig was over. On the beach it had been just another smidgen of bone in the rock. So no note was made on the day of its discovery as to who had found it. Therefore anyone who participated in the 2000 dig may have been the culprit!

When the second mammal discovered at Flat Rocks, *Teinolophos trusleri,* was named in early 1999, it was then regarded as a member of a completely extinct group of Mesozoic mammals called "eupantotheres". When Chuck Schaff came from Harvard to help Lesley Kool prepare a particularly recalcitrant *Ausktribosphenos nyktos* jaw fragment, because it was such a nerve wracking specimen to work on, for "rest and relaxation" (Chuck's words), he decided to try his hand at preparing the one molar preserved of *T. trusleri.* When he did so, we were dumbfounded because the crown of the tooth did not look anything at all like any "eupantothere". Instead, with one important difference, it was remarkably similar to the first Mesozoic mammal discovered in Australia, the Early Cretaceous monotreme from Lightning Ridge *Steropodon galmani.* The one important difference was that *T. trusleri* is only 22 percent the size of *S. galmani.* All other monotremes, both fossil and living, are within a factor of two, the same size. What this could mean as far as how *T. trusleri* may have been different from other monotremes in its physiology, we have not yet even started to think about seriously. Peter Trusler has modified his painting of *T. trusleri* to show the structure of this tooth as we now know it to be.

This year saw a number of skull fragments of dinosaurs turn up at Flat Rocks. Coupled with those that have been found previously, the quantity of such specimens from both Flat Rocks and Dinosaur Cove that have not yet been adequately identified is impressive. Courtesy of the National Geographic Society, Pat Vickers-Rich and I shall have an opportunity in November to visit a number of museums in North America to look in particular at the skulls of hypsilophodontids and small theropods in order to try and at least get started with determining just what these skull fragments represent. It was with pleasure, too, that we were able to name a new dinosaur, *Qantassaurus intrepidus*, illustrated on the front cover of this report, after Qantas airways. The type specimen, from the Flat Rocks site, is a lower jaw found by Nicole Evered. This honour is well deserved for the long support Qantas has given for dinosaur research and exhibitions.



Revised reconstruction of *Teinolophos trusleri*.

Site Report by Doris Seegets-Villiers

The Dinosaur Dreaming 2000 field trip marked the beginning of the third year of data collecting at the Flat Rocks Site for a Ph.D. thesis undertaken at Monash University. As in previous years, information on sedimentology, palynology, dendrology and taphonomy were taken and worked on during the year.

SEDIMENTOLOGY

For the sedimentology part we continued taking measurements of extent and thickness of the individual layers. As always, Mary Walters was the capable support person helping with this task. Measurements were taken almost the same way as last year employing the "assistance" not only of Mary but a few more devices: a compass, a thin rope, spirit level, plumb bob, tape measure and a stick. Split pins were again used as fixed orientation points. To measure the position of the boundary of a layer (or for that matter the bone orientation and the position of the bone) the stick would be placed on the boundary. With the help of the thin rope, plumb bob, level and the tape measure the distance and depth of the given point from our fixed point would then be measured. For last year's field season we used a compass to give us the derivation of that newly measured point from the fixed point. On windy days it was always very difficult to obtain accurate measurements. Taking readings on days like these was always a very lengthy process. This year, however, we had an innovation for this task. Nick, along with his buddy John, had built a gadget that sped up the process of measuring considerably. They enlarged a 360° protractor, scratched the bearings onto a plastic circle, fixed that to a metal base, which could, via a few metal clamps, be adjusted to the split pins. All that needed doing was adjust the protractor to any given split pin, align it north and start measuring. Readings were taken by aligning the string from the measuring stick to the middle of the protractor and reading the degree value off the plastic circle. Every year we are getting better adding more and more useful gadgets that speed up the excavation process.

PALYNOLOGY & DENDROLOGY

Palynological and fossil wood samples were taken in order to get more insight into what kind of plants were around during the time dinosaurs were living, mainly to try and get a better idea of the climatic conditions prevailing during the Early Cretaceous.

Palynological (spore/pollen) samples taken during last year's field season have turned out to be quite interesting. Zone indicators (grains that provide the approximate age of a deposition) in some of the samples define the age of the Flat Rocks Site as Early Albian to Late Aptian, an Early Cretaceous age. Most samples showed a very high number of individual pollen and spore grains but a very low diversity, which stands in direct contrast to other sites investigated in the Gippsland Basin. One of the samples was identified as a swamp derivative, due to the occurrence of mainly one species of spores and the fact that this species was forming clusters (individual grains are sticking together). This indicates a very low energy environment, something that is expected for a swamp environment.

Last year's samples were taken from a cryoturbation horizon found below the bone bed at the Flat Rocks Site. Cryoturbations are periglacial structures associated with seasonal freezing and thawing of soils. They only occur within a certain temperature frame of between the -3° to +4° Celsius mark. This year further samples were taken around this cryoturbation, around a second cryoturbation further to the north (or above the bone bed) and between these two cryoturbation levels. The purpose of investigating these samples was to determine if there are any changes in amount and diversity of pollen and spores in the samples of the periglacial areas and in between those areas. Cryoturbation areas indicate a cold time or a cold spell. Absence of these features does not necessarily mean warmer spells (they could just not have been preserved). If there is a difference however, in species diversity and abundance of grains between cryoturbation and non-cryoturbation areas, it could be an indication of colder and warmer times and it might be possible to identify species that were more adapted to colder conditions and those that were much more used to warmer spells. It will, therefore, be interesting to process and investigate the samples especially those from between the two cryoturbation horizons, to see if and what kind of differences there are between these samples.

Further samples of fossil wood from tree stumps have been taken as well. To the north and above the bone bearing horizon is an area that yields a number of fossil tree trunks. Of most of these, samples were taken and thin sections made to look at the pattern of the growth rings (dendrology). Trees growing under seasonal climate show a subdivision of the rings produced each year into early and late wood. Due to favourable conditions (warmth, rain, sun) the early wood (laid down at the onset of spring) is usually wide, the late wood (produced at the onset of less favourable conditions for growth (cold, darkness)) is narrower. This subdivision into early and late wood can be observed in some of the samples taken at the site. The early wood is usually very wide, whereas the late wood is very narrow. Occasionally so called false rings are present as well. They are created due to changes in growth conditions (frost, drought) during the otherwise fairly uniform growth of the early wood.

Although a few of the samples taken show the subdivision into early and late wood, a majority of them do not. While taking samples, care was exercised to make sure that the samples were taken perpendicular to the long axis of the tree in order to achieve a good cross section of the growth rings. Unfortunately, this did not happen. In most of the thin sections produced, small areas do show a few undisturbed growth rings but the main area of the section seems to be somehow distorted. Therefore, more samples need to be taken in the hope of obtaining a longer sequence of growth rings which can then be used for analysis of the climatic conditions and hopefully as well to identify the species of trees present at the site.

TAPHONOMY

For the taphonomic work, we again took as much data on bone orientation as possible. Features noted were as follows:

- the orientation towards North,
- the dip angle,
- the depth and distance from a fixed point,
- the layer in which it was found
- bone type (if that was possible to determine),

- which side was up
- which end (proximal or distal end) was pointing North.

As last year, we used our systems of chalk arrows to obtain additional orientation measurements. Each morning, after the hole was emptied, arrows, which pointed North, were drawn onto the exposed rock surface. It was then possible to obtain rough orientation measurements of bones found within large chunks of rock that had already been removed from their in situ position. Measurements taken are, of course, not very precise. They should however, not be more than 10° off their true value, which means we still get a pretty good idea about the rough bearing of the bone. It has to be pointed out, that in this case data like dip and positions of bone, and sometimes even the layer it came from were impossible to determine. Furthermore, the "upside" of the rocks exposed were marked as well.

After having trouble initially to source money for a freezer to conduct some experiments on fresh bones, money was provided through the Department of Earth Sciences at the Monash University and a freezer was purchased. That meant that, with the help of Mike Cleeland, a number of dead mutton birds could be collected at Forest Caves Beach on Phillip Island. Collection took place under a research permit granted by the Natural Resources and Environment Department. All birds were subsequently gutted and defeathered. The skeletons are presently frozen at constant temperature and ready to be used in the experiments.

Finally, thanks to all the volunteers for their constant support during the entire dig and of course to the Friends of Dinosaur Dreaming as well, whose financial support which enabled us to purchase the equipment mentioned by Lesley, made my task of collecting data much easier as well. Thanks to Chris Pierson in the workshop at Monash Earth Sciences for use of the respiratory mask in defeathering the mutton birds.

ACKNOWLEDGEMENTS:

As mentioned at the beginning of the report, the Dinosaur Dreaming 2000 field crew knew from the start that they had a lot to live up to after such a successful field season in 1999. We hoped at least to do as well as the previous year, but no-one expected such a great result. The number of fossil bones and teeth collected during the 6 week dig was reminiscent of the "good old days" when we didn't have the large amount of sand to remove from the site before we could get to the fossil layer. This result is a credit to all the crew members who gave their time and enthusiasm to volunteer for this dig. It has been said before, but each year it is obvious, that the love of fossils is a strong bond between people from different backgrounds and different countries. This field season saw the inclusion of crew members from interstate and overseas, including three volunteers from Germany, three from the United States and one from the United Kingdom.

Special mention must go to Katch Bacheller from Alaska, who originally joined the crew in 1999 for four weeks. Katch enjoyed herself so much she volunteered to return for the Dinosaur Dreaming 2000 in the capacity of "evil-overseer". In her official capacity as volunteer coordinator, Katch introduced a number of valuable initiatives and made all volunteers very welcome on their arrival

at the dig. She has kindly written a report of her experiences, which has been included at the end of the annual report.

Two other crew members, who also joined us from the U.S.A., have also included a report of their experiences on the dig. Al Fraser is a seasoned excavator. He first became involved in excavating in the Early Cretaceous of Victoria when he was an Earthwatch volunteer at Dinosaur Cove in the late 1980's. He subsequently returned to join Tom Rich on a number of field trips both in Australia and Argentina and when he asked to join us at Inverloch, we were delighted. His wife Laurie had never excavated in Australia before, but had joined Al on a number of field trips in the States. It was great having Al's experience and Laurie's great enthusiasm and their report makes interesting reading.

To everyone who took part in this year's dig, we would like to offer our sincere thanks and hope to see some of them again next year.

Katch Bacheller: Field Report:

In defining the success of the Flat Rocks 2000 dig, I attribute the ease of the work and focus of the volunteers to three things:

1. Excellent leadership.
2. The addition of new equipment and an assistant to this year's effort.
3. Exceptional efforts of the volunteer team.

1. Leadership

The volunteer team was a unique mix of individuals with differing life and work experiences. At any given time the volunteer team had, on average, 500 years of work experience between them - all striving toward the common goal of excavating early late cretaceous fossil-bearing rock and finding bones. This work was performed efficiently with good spirit and with no intermediate or major injury. (The occasional scrape is typical of this type of field site.)

Key to this work was the weekly on-site safety orientation given by the dig site manager, Nick Van Klaveren. Points stressed were; the possibility of electrocution and engine safety, equipment safety such as standing shovels up and immediate placements of tennis balls on the rock bolts as impalement guards.

Environmental concerns such as sunscreen and cliff safety were also stressed. The effects of these orientations were profound. Those team members with little or no site experience understood the specific hazards of the dig. Placing expectations such as, "I never want to see a shovel within 10 meters of an electrical cord," effectively created guidelines the team rigorously adhered to.

Breaking rock can be a mind-numbing experience. Exceptional leadership is required to promote an understanding and pride in all the specimens that are found by the dig team. Lesley Kool excels in this complicated role. Again, expectations are placed and rigorously adhered to.

Examples of these are: the expectations of finding a complete specimen, undergoing rigorous training before the dig and re-training the individual the first day they are on the dig.

Praise is crucial to this effort and Mrs. Kool is unusually sensitive to this. All specimens are met with equal enthusiasm and interest. In no way is any member of the team meant to feel unequal because of the specimens that they find. This generates enthusiasm and pride within the team and promotes good breaking practices.

2. Equipment and an additional leadership role

The addition of:

- Six WWII heavy duty backpacks (Previously, carrying buckets was heavily utilized.)
- One woman's internal frame backpack
- One WWI external frame pack for the rocksaw
- Velcro straps for strapping the generator to the trolley
- Velcro straps for nesting shovels together
- A mesh bag for the tennis balls (impalement guards)
- A white, dry erase information board. (This proved to be important to the smooth running of this dig).

All heavy loads were, this year, loaded and carried upon the back both down to the site and up to the car park. All excavated rock was placed into buckets that had been loaded into backpacks and carried up to the trailer in shifts. As many as four people were required to carry five or six loads each to transport the fossil rock to the house site for breaking. Total weights of transported rock sometimes exceeded 500 Kilos. Injuries were avoided through the use of the above-mentioned backpacks, particularly to the less youthful members of the team. Carrying heavy weight in buckets can never be utilized as a transportation method again. Any load exceeding 5 lbs. must be loaded into backpacks and carried upon the back.

Velcro straps were also effective in strapping together nested shovels thus making carrying them safer and more efficient. The use of heavy duty Velcro to strap the generator to the trolley, improved loading and unloading time. Additionally, a mesh bag for the tennis balls insured their being packed correctly for daily use on site as the contents of the bag could clearly be seen. The additions of this equipment radically improved the comfort and safety of the team.

At the house, the use of the white board was effective in imparting a large amount of information in a small amount of time. This led to a greater understanding of the "big picture" by the team and a more efficient way to impart chores and news. An example of the white board set-up will follow the end of this report.

As stated earlier, combined with Mrs. Kool and Mr. Van Klaveren, an additional leadership role was added to share their workload and provide leadership by example.

This person's duty was as follows:

- Orienting new team members as they arrived on site. Orientation included:
- An overall picture of the National Geographic sponsored dig and its importance to Paleontology in general. *
- Reviewing the "shoulder" bones (inferior and undiagnostic bones good only for throwing over one's shoulder) to re-claim previous training.
- Sitting with new team members while breaking rock until confident they were up to speed and to serve as an example in good breaking practices.
- Reviewing with new team members how the team works both at the house and on site, and reiterating safety issues.
- Placing daily work expectations such as loading and unloading the equipment.
- Maintaining a leadership presence on site by working hard, safely, and providing suggestions for those unable to ascertain what to do next.
- Maintaining the white board.
- Supervising the shopping and dinner rostering duties.
- Waking folks up in the morning.

The addition of this role was crucial to the 2000 dig. Teams of 20 and more require additional leadership examples. This leads to easier workloads for key field crew and a better understanding of expectations from the volunteer team. In no way can two team-leaders maintain a thoroughly safe and efficient environment without this additional help.

In the future, this leadership role could be split into two separate assistants.

An assistant to Mr. Van Klaveren whose duties could include:

- Daily assisting loading and unloading the equipment trailer.
- Placing and tagging the tarp for that day's rock and specifying the procedures and personnel for that specific day's rock.
- Providing additional safety examples on site – standing shovels up, making sure drums are not unloaded while team members are removing the large tarp, electrical safety, etc.
- Providing suggestions to onsite members unsure of what to do or when to do it.
- Serving as an example and setting the pace of the work in both site and field home locations.
- The person in this role must operate by suggestion rather than direct order. She or he exists as an example that team members should strive toward. The person in this role would excel in a good attitude, hard work and profound respect for others.

An assistant to Mrs. Kool whose duties could include:

- Maintaining the white board.
- Orienting new team members to the workings of the house.
- Promoting cleaning and maintenance of the field house and yard.
- Training new team members with "shoulder" bones.
- Serving as an example in rock breaking procedure.
- Maintaining the dinner roster.
- Shopping for groceries.
- Waking folks up in the morning.

This role must operate by suggestion and praise and have excellent organizational skills. In no way should this individual belittle any bone found on sites as this severely disrupts morale of the entire team. Additionally, this person should serve as a "soft wall," placing house rule expectations among the younger members of the team, gently and firmly.

These roles must be maintained throughout the dig without exception and could be traded throughout the dig in a "cross-training" exercise between assistants.

3. Exceptional efforts of the volunteer team

While leadership, orientation and equipment play a critical role in the smooth running of the dig, note must be taken of the performance of the volunteers.

The volunteers for the Flat Rocks site come from many backgrounds with varied work experience and are united by their love for dinosaurs. These folks work grueling 8 to 10 hour days, no matter the weather, to further scientific study. When calculating the combined totals of their salaries the members of this team would be making in their jobs, it comes to $5,000 to $8,000 US per day or $210,000 to $360,000 US for the 42 day dig.

These volunteers are a fun-hearted, great spirited team who literally move tons of rock up a 40-foot cliff only to break it up into tiny, sugar cubed sized pieces at the field house to find bones. They cook and, for the most part, clean. They often rise at 5:00am without grumbling to meet early tides. This team takes exceptional care in seeing tiny bones and congratulating each other on a good find. They are enthusiastic and supportive and function as a team synergistically without previously knowing each other.

As many of the volunteers are experienced backpackers, posting house rules is effective in maintaining clear expectations for the crew at rest. Cooking for the team, or assisting, is an important exercise in building confidence and leadership as well as further bonding the team together. During days that the tides are ineffective for site work, a two-hour cleaning binge to start the day answers most maintenance issues relating to cleaning. Orienting the team to sit in the sun to break rock and spot bones and to clean their tarps and stations daily is necessary for new team members. Again, the addition of assistants to coordinate this effort is necessary with larger team numbers.

It has been my sincere pleasure to have worked with the many fine individuals I have met on the Dinosaur Dreaming teams. I personally look forward to many more years in helping with this effort.

(Example of the white board)

DINOSAUR DREAMING 2000

DATE WEATHER

LOW TIDE

START TIME

ON SITE

WHO'S IN THE HOLE WAKE UP TIME

SCHOOL BOOKINGS

DINNER EQUIPMENT

ONSITE

TIDE INFO FOR WEEK

GENERAL INFO

The white board should be oriented toward information and productivity with a wee bit of fun thrown in.

This board should be updated as often as necessary, daily, hourly as weather changes. The expectation placed among crew members is to read it *often*.

Footnotes

*The Evolution and Extinction of Dinosaurs, by David Fastovsky and David Weishampel.

A View by Two Volunteers

By
Allan Fraser and Laurie Fletcher
29 February 2000

We had the opportunity to participate with the Dinosaur Dreaming 2000 Cretaceous fossil excavation project at Inverloch, Victoria in early February 2000. The primary goal of the work was to recover rare and largely unknown mammalian fossils from the early Cretaceous of Australia. These fossils are providing first

glimpses into this period in the relatively unknown Mesozoic evolution of mammals in Australia and Antarctica. The mammalian fossils, which are from puzzling new genera, may also have major implications for mammalian evolution and dispersal in the world as a whole. The Inverloch dinosaur material available at the dig is also developing the unique high-latitude dinosaur story started at Dinosaur Cove, Victoria. The fossil bone routinely found also included many fish and ubiquitous turtle fragments.

We had only eight full days available from work to spend at the site, which had been seasonally worked for a few years. We entered a going operation. We knew approximately what to expect, as we have participated in dozens of paleo projects between us, including three times at Dinosaur Cove. Upon arrival, Gerry Kool and Tom Rich met us at the Melbourne Airport. After a short stop at Monash University, Gerry took us directly to a rental house in Inverloch that was the base for operations. There we met the leader of the field operations, Lesley Kool, and several other dig participants - some known and others unknown to us. We moved our gear a few blocks to another, very pleasant, vacation house where Doris Seegets-Villiers and Mary Walters were staying. Mary and Doris were excellent companions and were helpful in all ways. At the main rental house there were typically about a dozen residents, with many of them staying in tents in the back yard.

The coastal platforms and cliffs all along the Gippsland coast are beautiful under all conditions of sea and sun. The excavation site, Flat Rocks, was a few kilometers from town and within Bunurong Marine Park. It is on a broad tidal platform of gray rock below sea cliffs. These cliffs and the platforms are the result of Early Cretaceous sedimentation by braided streams, which were located everywhere at different times and flowed at fairly low rates. The rock varies, but contains a lot of coarse sand and a lot of plant remains, most of which are now coal. Some of the rock shows signs of somewhat more rapid Cretaceous flows, perhaps from seasonal floods, as it contains rolled clay balls and some larger pebbles. The bones tend to exist in "layers" in places where the ancient streams deposited larger items from their flows. The layers are scattered about and not easy to find, and they usually have lateral extents of only a few meters. There is some low chance of finding fossil bone almost anywhere in the sediments, but actual finds are few and far between, and zones rich enough to warrant excavation are very scarce. The coastal sediments are eroding at up to a centimeter per year, and that makes it useful to revisit locations every few years to see if some fossil material has surfaced.

During our stay, the tides were low in mid to late morning. Weather permitting, we left for the excavation site at a bit pre-dawn to a couple of hours after sunrise. A generator, a pump, shovels, and a lot of other gear were carried down the stairs from the car park onto the rock platform and then were carried a couple of hundred meters along the platform to the worked pit. The pit had been under water at high tide, and sand had been moved about extensively. The pit had been protected from filling with sand. It was filled with one or two hundred plastic containers in the 10-20 liter range. The containers were covered with tarps, and the tarps were held down by rigid steel mesh. The mesh, in turn, was clamped to the rock platform by box beams that bolted to threaded rods which protruded from the bedrock. This plastic fill scheme was the invention of Nick Van Klaveren, who was Lesley's lead lieutenant on the rock platform and a very experienced fossil excavator.

The first job of the day was to open the pit. Sand was dug off the top. The beams and mesh were removed. More sand was removed from the tarps, and the tarps were moved aside. Meanwhile, the generator and the pump were set up, and the pump was used to drain the pit. All of this took a lot of effort, but it was a tiny fraction of what the work would have been if the pit were allowed to fill with sand twice per day. With the pit drained, Doris marked the stone with chalk to show the direction of stream flow in the Cretaceous, and she began records that would eventually allow identification of the locations from which the various finds came. Usually three people stayed in the pit and carefully split rock out, while most of the rest of the people spread out on convenient boulders on the platform and split rock that had come from the pit. The people "in the hole" had the difficult job of seeing fossils on wet rock and sometimes poor light. When they spotted a fossil, they looked for the other side of the break through which it was located. A section of *terra firma* was removed to make a matched pair with the loose "half" of the fossil. The majority of the people, sitting on the boulders, split rock and looked for fossils. Any finds were wrapped and marked before being taken back up the cliff. Much unsplit rock was also taken up to the vehicles and transported to the rental house. As the tide returned, the pit was refilled with plastic containers, and covered, and clamped, and usually people had just finished getting the gear off the platform as the tide reached the pit.

Back at the house the vehicles were unloaded, and people set up to split rock there. There was a bit of a break at this time involving food. The dig operation usually had three main meals per day and three snacks. The food was good and varied. Evening meals were prepared and clean-up was done on a rotating basis among the volunteers, all of whom were cooperative and responsible in this and all other ways. The rock splitting at the house was done fairly communally, with sort of beginning and ending times, but there was plenty of flexibility for personal errands, fatigue, and enthusiasm. Splitting rock with the group was accompanied by diverse discussions, many about the rock and the bone and the environment of their deposition. The crew was typical of paleo volunteer groups with biases towards under-twenty-five-years-olds and those over fifty. Often a boom box was played, and on hot days there would reliably erupt a boys-against-the-girls youth water fight with armament escalating from squirt guns to buckets.

The rock splitting was done on heavy stones set on stumps. Small (about 2 kg) mallets were used with chisels to break the rocks down to nominal cubic centimeter pieces. Important tooth fossils were far smaller than a centimeter, and the prized jaws were only a couple of centimeters long. As rock was broken, normal paleontological technique was used to keep track of both sides of fractures, as a visible fossil was invariably partly on one side of a break and partly on the other. Any find was taken to the inspection station under the roof of the back porch, where it was determined to keep it or not. These operations were well supervised by Lesley, with Marion Anderson and Katch Bacheller acting as lieutenants who were available to advise and solve problems. As most of the important fossils were small, all rock-breakers had 10X magnifiers to examine the organic specks that appeared on the broken rock surfaces. What one found was largely a matter of luck and the piece of rock with which one started. Most people found at least a few fossils per day with occasional exceptional finds of dinosaur teeth, tiny hollow long bones, or really well

preserved dinosaur bones. One known mammal jaw was found at Dinosaur Dreaming 2000 prior to our arrival, and one was found while we were there by a student in her first day of digging.

There were opportunities to do more than lug tools, dig, and split rock. Many times the experienced or local people showed new folks the local geology, geography, and points of cultural interest. Within the scope of the project, on one day Mike Cleeland took some people to the nearby Eagle's Nest point to prospect for bone. On another day Mike identified some likely fossil deposits by Eagle's Nest, and rock split out from one of them produced about 15 bones from not more than 40 liters of rock.

Our Dinosaur Dreaming 2000 experience was excellent. We think that everybody did a very good job. We have, however, been asked about what we would do differently, so we respond even though we have far less experience with the specifics of the Flat Rock situation. It would be worth it to try to work the pit more stratigraphically, with large breaks made as parallel to the bedding as possible. The bedding is poor in this rock, and it is not easy to cut out blocks instead of making rubble. But it is possible to get larger blocks with higher volume-to-surface ratios, as Lesley and Al did in the floor of the Dino Cove cross tunnel in 1993 and in contrast to the way most Dino Cove rock was removed. In 1993, we removed the irregular shards from edges, weakened intended vertical edges, and then worked the rock parallel to the bedding. The larger blocks of rock removed meant fewer time-consuming surface searches and "other half" removals in the pit. By this means more rock is removed per day. This approach, besides producing more rock and fewer shards per unit time in the pit, translates to more economical use of the major overheads of pit opening and closing, and beach transport cycles. There would likely be better bone retrieval, as well, as more of the rock would be split under controlled conditions and dry. Making this change, however, if it worked, would change the culture of the dig in one way that would make it less desirable to many volunteers: more time in the back yard and less time at the beach. The efficiencies gained by getting say, twice as much rock per beach trip, could be partly used to afford more prospecting and evaluation of other sites, which would offset the boredom of increased back yard time.

DINOSAUR DREAMING 2000 FIELD CREW

Marion Anderson
Kate Archdall
Katch Bacheller
Nicola Barton
Rachel Blakey
Michelle Bold
Merice Briffa
Bernhard Chapligin
Mike Cleeland
Roger Close
Alison Dorman
Caroline Ennis
Alan Evered
Nicole Evered
Anne Faithfull
Laurie Fletcher
Al Fraser
Paula Fuge-Larsen
Priscilla Gaff
Norman Gardiner
Jillian Garvey
Draga Gelt
Dean Gilbert
Liz Irvine
Briana Jones
David Jones
Patricia Komarower
Gerrit Kool
Lesley Kool
Anne Leorke
Anna Lichtschlag
Rohan Long
Alanna Maguire
Dru Marsh
Debbie Peeters
Sandra Pfeifenberger
Audrey Rowe
Brian Rowe
Nick Sambrooks
Doris Seegets-Villiers
Natalie Schroeder
Leah Schwartz
Terry Smith
Dan Timblin
Nick Van Klaveren
Mary Walters
Astrid Werner
John Wilkins
Corrie Williams
Dean Wright

Without the financial and material support of our generous sponsors it is obvious that the Dinosaur Dreaming project would not exist. This year was no exception. The National Geographic Society once again provided the bulk of the financial support, ably assisted by the Friends of Dinosaur Dreaming, whose subscriptions provided us with the replacement of essential equipment. Australian Research Grants Committee provided an air ticket for Nicola Barton as well as funds for preparation. Evan Evans Flags provided a made to measure heavy-duty tarpaulin that protected the site during the daily inundations. Ingersoll Rand and Atlas Copco provided the equipment necessary to set up the system, which prevented most of the sand from re-entering the excavation. The steel-cap boots, kindly donated by Blundstone Pty Ltd, were gratefully received by the members of the field crew.

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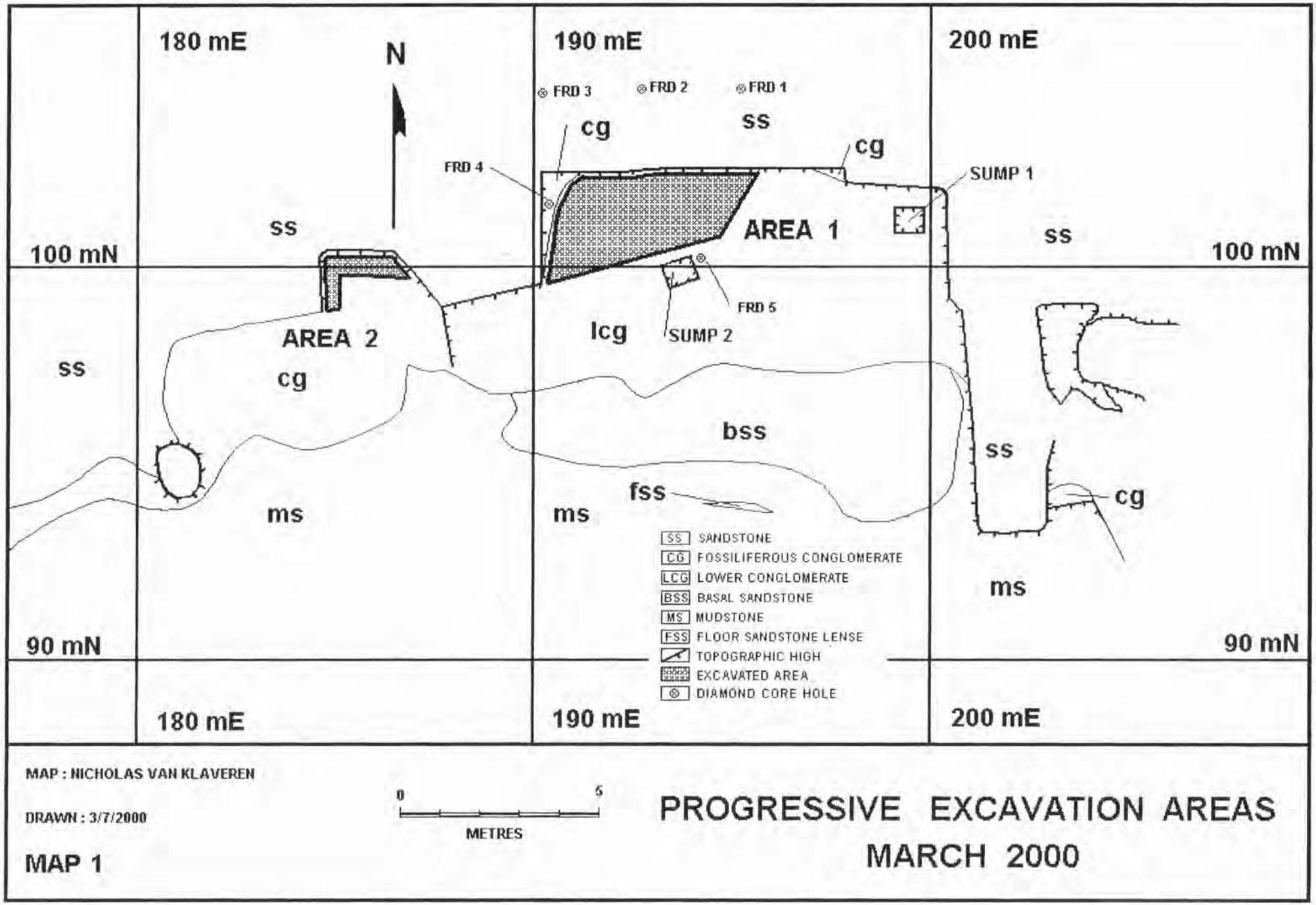

MAP : NICHOLAS VAN KLAVEREN

DRAWN : 3/7/2000

MAP 1

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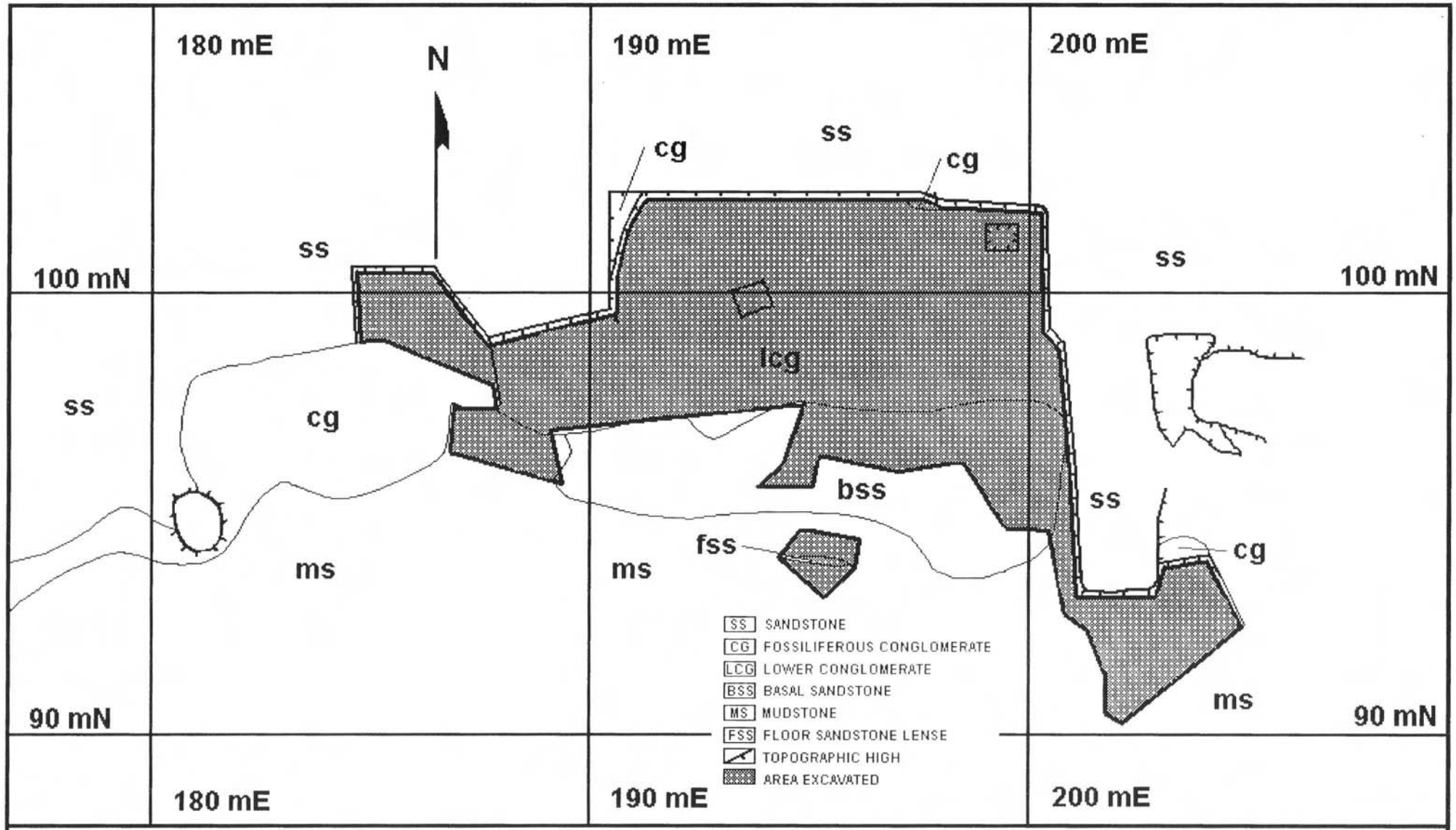
METRES

PROGRESSIVE EXCAVATION AREAS MARCH 2000



MAP : NICHOLAS VAN KLAVEREN

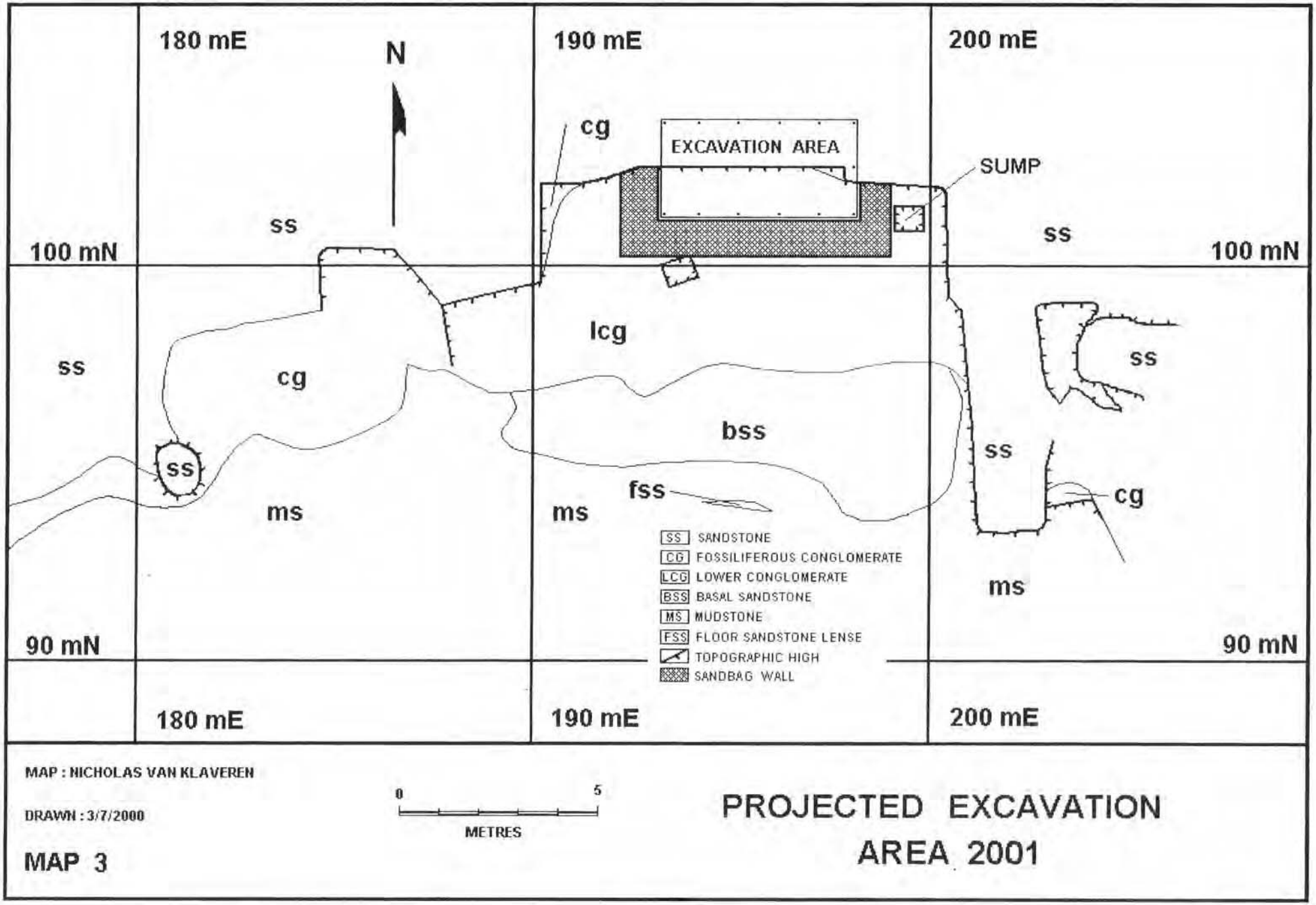
DRAWN : 3/7/2000

MAP 2

0 5

METRES

CUMULATIVE EXCAVATION AREAS MARCH 2000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bss
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ss
fss
cg
ms
ms
ms
SS SANDSTONE
CG FOSSILIFEROUS CONGLOMERATE
LCG LOWER CONGLOMERATE
BSS BASAL SANDSTONE
MS MUDSTONE
FSS FLOOR SANDSTONE LENSE
TOPOGRAPHIC HIGH
SANDBAG WALL
90 mN
90 mN
180 mE
190 mE
200 mE
MAP : NICHOLAS VAN KLAVEREN
DRAWN : 3/7/2000
MAP 3
0
5
METRES
PROJECTED EXCAVATION
AREA 2001

Dinosaur Dreaming acknowledges the generous contributions of the following sponsors:

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Monash University Research Fund

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Peter Trusler, Melbourne